CLAIMS

What is claimed is:

1. A method of fuel cell start-up for a fuel cell system having a hydrogen source connected to an anode inlet of a fuel cell stack, an oxygen source connected to a cathode inlet of the fuel cell stack, and a low voltage power source, the cathode inlet being connected to a high voltage compressor and to a low voltage blower, the method comprising:

introducing hydrogen to the anode inlet of the fuel cell stack;

operating the low voltage blower with the low voltage power source for supplying oxygen to the cathode inlet of the fuel cell stack; and

producing a voltage output with the fuel cell stack.

2. The method of claim 1, further comprising:

applying an electrical load to the fuel cell stack via the compressor for supplying additional oxygen to the cathode inlet; and

increasing the electrical load applied to the fuel cell stack via the compressor over time to supply additional oxygen to the cathode inlet.

3. The method of claim 2, further comprising monitoring the voltage output of the fuel cell stack and wherein applying an electrical load to the fuel cell stack via the compressor is initiated after the voltage output of the fuel cell stack has reached a predetermined value.

4. The method of claim 2, wherein increasing the electrical load applied to the fuel cell stack via the compressor over time is performed gradually.

5. The method of claim 2, wherein increasing the electrical load applied to the fuel cell stack is performed by an electronic controller that monitors cell voltages of the fuel cell stack and commands a compressor motor to load the fuel cell stack and to increase the load on the fuel cell stack as the cell voltages of the fuel cell stack increase.

6. The method of claim 2, wherein increasing the electrical applied load to the fuel cell stack is performed until the fuel cell stack produces enough electrical power to operate at a positive net power.

7. The method of claim 1, wherein introducing hydrogen to the anode inlet includes opening a valve to release hydrogen flow to the anode inlet.

8. The method of claim 7, wherein said valve is opened manually.

9. The method of claim 7, wherein said valve is opened by an electronic solenoid.

10. The method of claim 1, further comprising decreasing the operation of the blower over time as the voltage output of the fuel cell stack increases.

11. The method of claim 1, further comprising ceasing operation of the blower when the voltage output of the fuel cell stack has reached a predetermined value.

12. The method of claim 1, further comprising ceasing operation of the blower when the voltage output of the fuel cell stack is sufficient to support operation of the compressor.

13. A method of fuel cell start-up for a fuel cell system having a hydrogen source connected to an anode inlet of a fuel cell stack and an oxygen source connected to a cathode inlet of the fuel cell stack, the cathode inlet being connected to a high voltage compressor and to a low voltage blower, a cathode side of the fuel cell stack containing oxygen prior to start-up, the method comprising:

introducing hydrogen to the anode inlet of the fuel cell stack for producing a voltage with the fuel cell stack;

operating the low voltage blower with the voltage of the fuel cell stack for supplying additional oxygen to the cathode inlet of the fuel cell stack via the blower; and

increasing the voltage produced by the fuel cell stack over time.

14. The method of claim 13, further comprising:

applying an electrical load to the fuel cell stack via the compressor for supplying additional oxygen to the cathode inlet; and

increasing the electrical load applied to the fuel cell stack via the compressor over time to supply additional oxygen to the cathode inlet.

15. The method of claim 14, further comprising monitoring the voltage output of the fuel cell stack and wherein applying an electrical load to the fuel cell stack via the compressor is initiated after the voltage output of the fuel cell stack has reached a predetermined value.

16. The method of claim 14, wherein increasing the electrical load applied to the fuel cell stack via the compressor over time is performed gradually.

17. The method of claim 14, wherein increasing the electrical load applied to the fuel cell stack is performed by an electronic controller that monitors cell voltages of the fuel cell stack and commands a compressor motor to load the fuel cell stack and to increase the load on the fuel cell stack as the cell voltages of the fuel cell stack increase.

18. The method of claim 14, wherein increasing the electrical load applied to the fuel cell stack is performed until the fuel cell stack produces enough electrical power to operate at a positive net power.

19. The method of claim 13, wherein introducing hydrogen to the anode inlet includes opening a valve to release hydrogen flow to the anode inlet.

20. The method of claim 19, wherein said valve is opened manually.

21. The method of claim 19, wherein said valve is opened by an electronic solenoid.

22. The method of claim 13, further comprising decreasing the operation of the blower over time as the voltage output of the fuel cell stack increases.

23. The method of claim 13, further comprising ceasing operation of the blower when the voltage output of the fuel cell stack has reached a predetermined value.

24. The method of claim 13, further comprising ceasing operation of the blower when the voltage output of the fuel cell stack is sufficient to support operation of the compressor.

25. A method of fuel cell operation for a fuel cell system having a hydrogen source connected to an anode inlet of a fuel cell stack and an oxygen source connected to a cathode inlet of the fuel cell stack, the cathode inlet being connected to a high voltage compressor and to a low voltage blower, the method comprising:

operating the fuel cell stack in a stand-by mode when normal operation of the fuel cell stack is not needed, operating the fuel cell stack in the stand-by mode including:

monitoring a voltage of the fuel cell stack;

maintaining the voltage of the fuel cell stack above a predetermined minimum value by:

selectively introducing hydrogen to the anode inlet of the fuel cell stack; and

selectively operating the low voltage blower with the voltage of the fuel cell stack to supply oxygen to the cathode inlet of the fuel cell stack via the low voltage blower.

26. The method of claim 25, further comprising starting-up the fuel cell stack from the stand-by mode when normal operation of the fuel cell stack is needed, starting-up the fuel cell stack from the stand-by mode including:

introducing hydrogen to the anode inlet of the fuel cell stack;

operating the blower with the voltage of the fuel cell stack;

supplying oxygen to the cathode inlet of the fuel cell stack via the blower; and

increasing the voltage produced by the fuel cell stack over time.

27. The method of claim 26, wherein starting-up the fuel cell stack further includes:

applying an electrical load to the fuel cell stack via the compressor for supplying additional oxygen to the cathode inlet; and

increasing the electrical load applied to the fuel cell stack via the compressor over time to supply additional oxygen to the cathode inlet.

28. The method of claim 27, wherein starting-up the fuel cell stack further includes monitoring the voltage output of the fuel cell stack and wherein applying an electrical load to the fuel cell stack via the compressor is initiated after the voltage output of the fuel cell stack has reached a predetermined value.

29. The method of claim 27, wherein increasing the electrical load applied to the fuel cell stack via the compressor over time is performed gradually.

30. The method of claim 27, wherein increasing the electrical load applied to the fuel cell stack is performed by an electronic controller which monitors cell voltages of the fuel cell stack and commands a compressor motor to load the fuel cell stack and to increase the load on the fuel cell stack as the cell voltages of the fuel cell stack increase.

31. The method of claim 27, wherein increasing the electrical load applied to the fuel cell stack is performed until the fuel cell stack produces enough electrical power to operate at a positive net power.

32. The method of claim 26, wherein introducing hydrogen to the anode inlet includes opening a valve to release hydrogen flow to the anode inlet.

33. The method of claim 32, wherein said valve is opened manually.

34. The method of claim 32, wherein said valve is opened by an electronic solenoid.

35. The method of claim 26, wherein starting-up the fuel cell stack further includes decreasing the operation of the blower over time as the voltage output of the fuel cell stack increases.

36. The method of claim 26, wherein starting-up the fuel cell stack further includes ceasing operation of the blower when the voltage output of the fuel cell stack has reached a predetermined value.

37. The method of claim 26, wherein starting-up the fuel cell stack further includes ceasing operation of the blower when the voltage output of the fuel cell stack is sufficient to support operation of the compressor.

38. The method of claim 25, wherein operating the fuel cell stack in a stand-by mode further includes allowing the voltage of the fuel cell stack to decrease to a predetermined value before introducing hydrogen and operating the blower.

39. The method of claim 35, wherein during operation of the fuel cell stack in the stand-by mode, allowing the voltage of the fuel cell stack to decrease to the predetermined value is done repetitively.

40. The method of claim 35, wherein during operation of the fuel cell stack in the stand-by mode hydrogen is not introduced and the blower is not operated while the voltage of the fuel cell stack is allowed to decrease to the predetermined value.

41. The method of claim 25, wherein operating the fuel cell stack in the stand-by mode includes introducing a steady light stream of hydrogen to the anode inlet of the fuel cell stack and supplying a steady light stream of oxygen to the cathode inlet of the fuel cell stack via the blower.

42. The method of claim 25, wherein maintaining the voltage of the fuel cell stack is performed by an electronic controller that monitors cell voltages of the fuel cell stack and that commands the selective introduction of hydrogen and the selective operation of the blower.

43. A fuel cell system comprising:

a fuel cell stack having an anode side with an anode inlet and a cathode side with a cathode inlet, said fuel cell stack operable to convert a hydrogen-containing reactant on the anode side and an oxygen-containing reactant on the cathode side into electricity, an anode effluent and a cathode effluent;

a hydrogen-containing reactant source connected to the anode inlet;

an oxygen-containing reactant source connected to the cathode inlet;

a low voltage blower connected to the cathode inlet and operable to supply oxygen-containing reactant from said oxygen-containing reactant source to the cathode inlet; and

a high voltage compressor connected to the cathode inlet and operable to supply oxygen-containing reactant from said oxygen-containing reactant source to the cathode inlet.

44. The fuel cell system of claim 43, further comprising a low voltage power source and wherein said low voltage power source drives said blower.

45. The fuel cell system of claim 44, wherein said low voltage power source is a battery.

46. The fuel cell system of claim 44, wherein said low voltage power source is a capacitor.

47. The fuel cell system of claim 43, wherein said compressor is powered by said fuel cell stack.

48. The fuel cell system of claim 47, wherein said compressor is powered by said fuel cell stack once said fuel cell stack is producing voltage above a predetermined value.

49. The fuel cell system of claim 43, wherein said blower is powered by said fuel cell stack.

50. The fuel cell system of claim 43, wherein said oxygen-containing reactant stream is ambient air.